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ABSTRACT

The Atlantic Science Curriculum Project was launched in 1976 at the Atlantic Institute of Education in Halifax, Nova Scotia, Canada, as a regional initiative. This account of the project provides its aims, its experience, and its lessons for others similarly engaged in the task of improving curriculum and instruction. This paper was written at a time when the Project was changing from a regional initiative to a national and international collaborative effort related to curriculum development and research. (TW)

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The Atlantic Science Curriculum Project in Perspective

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The Atlantic Science Curriculum Project in Perspective

The Atlantic Science Curriculum Project was launched in 1976 at the Atlantic Institute of Education in Halifax, Nova Scotia as a regional initiative. This account of the Project, its aims, its experience, its lessons for others similarly engaged in the task of improving curriculum and instruction responds to growing public interest. It is a personal account. It may serve as one of the documents that curriculum scholars may wish to utilize in evaluating the Project and its significance for Canadian and international education.

This paper is written at a time of transition of the Project from a regional initiative to a national and international collaborative effort. Very much in mind, therefore, is the need to share the experience of the Project with those educators joining it. These include teachers using its products to teach science at the junior secondary level and others collaborating in preparing new editions, assisting in the dissemination and implementation of these products and conducting associated research.

Proceeding from a brief history, attention is given in this paper to the goals of the Project, the perspectives which have guided it, the place of the Project in the international movements to reform education and possible lessons for others engaged in effecting change in education.

Brief history

In the spring and again in the fall of 1976, at the initiative of the Atlantic Institute of Education, science teacher educators and curriculum consultants from the four Atlantic Provinces of Canada met to share experiences and discuss possibilities for collaboration to improve science education in the region. An organization, Educators of Atlantic Science Teachers (EAST) and a project, The Maritime Junior High Science Curriculum Project, were born. The Atlantic Institute of Education provided administrative support.

The junior secondary level of science teaching was singled out for attention by several members of EAST because (1) the need and possibility for improvement at that level seemed great and (2) the task of working with the science teachers at this level seemed far more manageable than similar attention to the much larger body of elementary teachers. In other words, the probable ratio of impact to effort was greater. It was decided to address the perceived need for inservice teacher education and more suitable curriculum materials by linking the two. (Haysom, 1976; McFadden, 1976)

By the spring of 1977 a formative evaluation of science teaching at the junior secondary level and a curriculum writing course were planned. The formative evaluation was carried out in June and the course convened at Saint Mary's University in Halifax, The University of New Brunswick in Fredericton and the Nova Scotia Teachers College in Truro during the summer session of 1977, by the Atlantic Institute of Education in three Nova Scotia centres during the 1977-8 winter session and at Mount Allison University in Sackville, NB during the 1978 summer session. In total, 90% of the 800 junior high science teachers in Nova Scotia and New Brunswick responded to the Project's survey questionairre (Morrison, 1978; McFadden, 1980b) and over 100 participated in the curriculum writing courses. At least 100 more teachers subsequently tried out one or more of the forty plus units created by the course participants.

The products of the curriculum writing courses included materials for the

teacher and activity worksheets for use by the students. The curriculum writing courses were judged by the participants to have been an excellent form of inservice education. The curriculum products were equally highly praised and have been widely used in schools in the region. The demand for suitable textbooks for students, however, remained.

In the spring of 1978 the Project was approached by a publishing firm with a proposal that the Project develop a series of student textbooks and teachers' guides. After consultation with the teachers, the Project agreed to take on this task. The very best of the writers from the curriculum writing courses were asked to assist in writing the materials. A team of nearly 30 teachers was assembled for this purpose.

Two years later, after slow progress in the development of materials, the Project was released from its publishing contract. In the meantime, most of the writing tasks were assumed by the original, smaller group of Project organizers. By the summer of 1982, most of the intended units for a three year sequence of textbooks had been written and tried out in classrooms. The Project had also been renamed the Atlantic Science Curriculum Project (ASCP).

During the summer of 1982, the Province of Nova Scotia announced that it was discontinuing its funding of the Atlantic Institute of Education, leading within months to the closure of the institution which had initiated and nurtured the Project. In response to this situation, other institutional supporters of the Project increased their assistance. The Technical University of Nova Scotia provided a home for the Project from the fall of 1982 until the summer of 1984. The University of New Brunswick enabled Professor Earl Morrison to spend the better part of the following two years to pull the materials together and ensure a uniformly high quality. The teacher and scientific organizations in the region vigorously supported the efforts of the Project to raise funds for the completion of its work, assisting it in obtaining support from the Secretary of State of Canada.

Concurrently, the Project resolved the problem of selecting one of the several publishers who had expressed interest in publishing its materials by asking for a greater than usual commitment of support. The offer which was ultimately accepted (from Harcourt Brace Jovanovich, Canada) included provision of a local supporting editor, extensive field testing, photo research and a major commitment to graphic design and illustration. This latter was particularly important because of the Project's emphasis on utilizing the graphic potential of a textbook for creating learning resources, including photo interpretation exercises, puzzles, games, charts, graphs and diagrams. Generous use of color was later committed by Harcourt Brace Jovanovich, Canada to the production.

The administrative centre of the Project was transferred in 1984 to the University of New Brunswick, which signed the publishing contract on behalf of the Atlantic Science Curriculum Project with Harcourt Brace Jovanovich, Canada. Publisher organized field trials of the grade 7, 8 and 9 units and teachers resource materials were conducted in the 1984-5, 1985-6 and 1986-7 school years, respectively. SciencePlus1 and Teachers Resource Book 1 were published in July 1986 with publication of SciencePlus2 scheduled for July 1987 and SciencePlus3 for spring 1988.

An implementation research team is being led by Professor John Haysom at Saint Marys University in conjunction with the use of SciencePlus in most Nova Scotia classrooms. A two volume edition of SciencePlus is currently being

prepared for Ontario schools, with publication scheduled for the spring of 1988. And in response to interest from the United States, discussions are now in progress with a view towards collaboration with U.S. educators to develop an edition or editions of SciencePlus suitable for their use.

Goals

The Atlantic Science Curriculum Project was not launched to fulfil a number of mutually agreed goals. Even to this day there has been no formal discussion and agreement on the goals of the Project. Most Project participants would (and privately did) advance modest goals for their own participation. Nevertheless, none of the accomplishments of the Project has been accidental. All are the result of the purposeful activity of its contributors, including the institutions and organizations which have made the Project possible. The Project has been shaped by the community that nourished it and by the personalities who found in the Project a vehicle for contributing to the improvement of education.

Regional cooperation Foremost was the role of the Atlantic Institute of Education. During its existence from 1970 to 1982 it was arguably one of the few institutions of higher education in Canada dedicated principally to the improvement of education. In contrast to institutions which primarily perform a reproductive function, the AIE had very little direct responsibility for the maintenance of the educational system, which probably explains why it became the victim of government fiscal constraint. It was mandated by an act of the Nova Scotia legislature to promote cooperation between the various faculties of education in the region. In practice, it served as a magnet which brought together many of the most creative members of the teaching profession, facilitating their contributions to the improvement of education. It was a center of research and development activity. As its representative and with the active encouragement and support of its administration, the author consciously made the Project a vehicle for the fostering of regional cooperation to improve education and the development of the self-esteem and creative activity of the teaching profession in the region. These then can be ascribed as principal goals of the Project.

Improving science education Each of the educators who came together to organize the Project had individual responsibilities to their respective employers to make a contribution to science education. In some cases this included responsibility to contribute to research and development and in all cases to contribute to the professional preparation or in-service professional development of science teachers. Therefore, the improvement of science teaching through the education of teachers, the development of curriculum materials and the conduct and dissemination of research can be ascribed as principal goals of the Project. These were accomplished initially through the wedding of inservice teacher education and curriculum materials development, with the emphasis subsequently shifting to curriculum development and implementation, all supported by research activity.

Science education in a Canadian context The Project was born at a time of heightened public attention to the issue of Canadian content in education, focussed by publication of The Symons' Report (1978, as an abridgment of the 1975 report of the Commission on Canadian Studies, headed by Professor T.H.B. Symons.) The attention given by the Commission to science education was summarized in a discussion paper prepared for the Science Council of Canada by James E. Page (A Canadian Context for Science Education, 1979), who proposed

the study of science education in Canada subsequently undertaken by the Council. The Atlantic Science Curriculum Project has consistently worked to represent in the form of learning materials what the Symons' Commission and its descendants have presented as policy recommendations for science education. This includes illustrations of scientific concepts and principles using examples taken from the students' surroundings and attention to scientific and technological activity in Canada, past and present.

Quality In conjunction with the decision to shift the emphasis of the Project to curriculum development there was an informal, but nonetheless operative agreement among the Project organizers that nothing would be submitted for publication which did not represent an improvement over available English language materials for junior secondary level science teaching and match in quality the best of materials available at any level for science teaching. The criterion of quality was simply the opinion of the Project organizers, who called themselves "editors" during the early history of the Project, but ultimately did most of the writing of the publishable materials, and therefore in relation to this material might better be described as the "principal author team". This seemingly vague and indefinable criterion of quality was in practice quite stringent. The principal authors have always been the severest critics of their own and each others work. No-one has been permitted to escape from extensive research and the exercise of imagination. All have been constrained to work in a problem solving mode, so that even highly imaginative material has been rejected when it did not appear to help solve a pedagogically significant problem. At the same time, there has been a great deal of trust in each other's judgement, with classroom trials used to resolve disputes.

Finding a path to curriculum improvement in Canada The author has frequently reflected publicly on the obstacles to improving curriculum and instruction in the specific conditions of Canada (McFadden, 1980a, 1980b, 1981,1983). These conditions include (1) the absence of significant federal government presence in education and the lack of substantial private foundation funding for curriculum change, in effect a reliance on the United States and the United Kingdom to renovate curricula, (2) a relative absence of interprovincial cooperation in education, leaving provinces with relatively modest means the full responsibility for curriculum renovation within their jurisdiction and (3) a lack of uniformity in the structure and duration of general education across the country, reducing the financial viability of commercial curriculum development projects and the amounts publishers are willing to invest in this task. The Project therefore has been an attempt to find a path to curriculum change in Canada or failing that to discover the barriers to reform and the limits to which reform can occur under present conditions.

Promoting international cooperation in education The Atlantic Science Curriculum Project has been both beneficiary and contributor to international collaboration in education, with the emphasis on learning in the early stages of the Project and a growing emphasis on contributing to others at the present time. In particular, one of the project leaders, John Haysom, brought to the Project his prior experience as a coordinator of the Science Teacher Education Project in the UK (Haysom and Sutton,1974). The promotion by the AIE and the British Council of contacts between educators in the Atlantic provinces and the UK, together with John Haysom's personal contacts, led to formal and informal collaboration between ASCP and science educators in the UK, particularly with Clive Carre, Exeter University, whose work on language in science (Carre, 1981) and visual communication in science (Barlex and Carre, 1985) especially influenced the Project. Also, in 1979, the author organized

an international conference on world trends in science and technology education, convened in Halifax by the Atlantic Institute of Education. This conference led to the formation of the International Organization for Science and Technology Education (and also to the establishment of the Canadian Association for Science Education). Through the conferences of IOSTE, the Atlantic Science Curriculum Project, along with Canadian science education in general, gained from and contributed to international experience. Presently, contacts made through IOSTE are providing the basis for collaboration to bring the benefits of the Project's research and developmental work to other countries. Raising the level of educational activity in Canada, benefitting from international experience and, in turn, facilitating a Canadian contribution to the improvement of education world-wide are goals which the Atlantic Science Curriculum Project has furthered.

Theoretical perspective

As in the case of its goals, the Atlantic Science Curriculum Project has never formally and explicitly expressed the theoretical framework which guides its efforts to bring about educational renovation. Leadership in the Project has come from university-based science educators who have been guided by their acquaintance with North American and British experience and research on attempts to improve curriculum and instruction. In addition, Soviet educational research and experience has had a significant influence on the author's perceptions (McFadden, 1982, 1985). One result of this combination of influences is the conviction that change cannot be effected by altering only one element in a system. For example, in the system of education, it is thought insufficient to change any one of the following: curriculum guidelines, textbooks, facilities and equipment, research priorities, in-service teacher preparation, pre-service teacher education, school organization or school climate. A change from a system of education whose main practical characteristic is the transmission of information for short-term recall to a system of education capable of developing the students' understanding and their ability to process and use information requires concurrent, mutually supportive change in all the essential elements of the system. This conviction explains the resistance of the Project to restricting its activity to any of the particular domains that concern its partners (for example, the interest of the Publisher in a product, the interest of higher educational institutions in teacher education and research or the interest of school authorities in inservice teacher education).

ASCP in the context of educational reform

The period of two decades from the latter 50s through the early 70s was one of intense discipline-centred educational reform throughout the world. The critique of the shortfall of this reform (for example, Goodlad, 1966; Havelock, 1975; Baez, 1976; Waring, 1979) created the theoretical basis for a new wave of curriculum reform which is now in progress. If the earlier period of reform focused on adjusting the content of education to the advances in science, the new wave of reform corresponds to the need to make modern science and technology accessible to all.

In his critique of the 50s and early 60s curriculum reform movement in the United States, John Goodlad (1966, p.98) gave the reform high marks for reconditioning "shockingly outworn courses." Its lasting contribution, one that today's curriculum reformers "cannot afford to ignore", includes "the identification of the concepts, principles and methods of inquiry worth

teaching and learning." (Goodlad, 1966, p.114)

Albert Baez (1966), a prominent contributor to the reform, observed that leadership of the reform projects was by scientists who possessed a knowledge of the modern content of their fields. Their prestige enhanced acceptance of the reform and their entrepreneurial spirit, inventing and promoting in spite of what seemed like insurmountable obstacles, ensured a measure of success. Their principal methodological contribution was to present science as a system of inquiry rather than as static bodies of knowledge.

A generation of scientists emerged in the United States and the United Kingdom, nurtured in their formative years by the spirit and content of the reform projects. The impact of the reform on general education in science was not so positive, however. While those headed for scientific careers emerged from secondary education more knowledgeable and devoted to the field than ever, general secondary enrolment in science and average achievement both dropped. (See, for example, the joint report (1980) to the President of the United States from the U.S. Department of Education and the National Science Foundation, Science and Engineering Education for the 80s and Beyond.)

The criticisms made of the limitations of the reform movement help us to understand and explain the seemingly contradictory results. As Baez (1976, p.91) noted, the scientists who led the reform movement were "not experienced in teaching at high school and elementary levels." They "did not know enough about the learning process." "...Planning from the top down," Goodlad (1966, p98) commented, "brought with it a straightjacket, incongruously ill-suited to childhood schooling. A really significant reform movement, therefore, looks ahead to a time when the curriculum will be planned from the bottom up, with the knowledge of students and their achievements built into the sequence of subject matter in the curriculum design."

The discipline-centred focus of the reform left out of its view many of the general goals of education, including the linkage of knowledge with preparation for citizenship and work. Goodlad (1966, p.92) observed that "such traditional social aims as preparation for citizenship or for intelligent participation in decisions facing the community" were "only rarely mentioned." With respect to the Nuffield projects in the U.K., Mary Waring (1979, p.228) found that there was "little on the social context of science and even less on the historical." The treatment of applications, she noted, was invariably "technologically sweet", "stressing benefits and ignoring the problems and the questions". In their report to the President, the DOE and NSF (1980, p.50) pointed out that "very little in the content of courses provides information related to personal or societal problems, about technology and what engineers do, or to vocational relevance except to those students interested in professional science careers."

The critics of the reform period were unanimous in stressing the need for effective in-service preparation of teachers for curriculum change. "Long conditioned to deductive approaches, many teachers," Goodlad (1966, p.103) observed, " turn materials intended for student investigation into objects of rote response...Curriculum planners must not stop with the production of materials. If the proposed changes are worth introducing at all, then they must be introduced thoroughly with careful attention to every component of the change process." Waring (1979, p.233-4) pointed out that not enough attention was given to how materials will be used; there is a need for curriculum innovation and development within a new conception of inservice work. In the

FIGURE 1 - The rate of accumulation of information has increased with the growth of scientific activity.

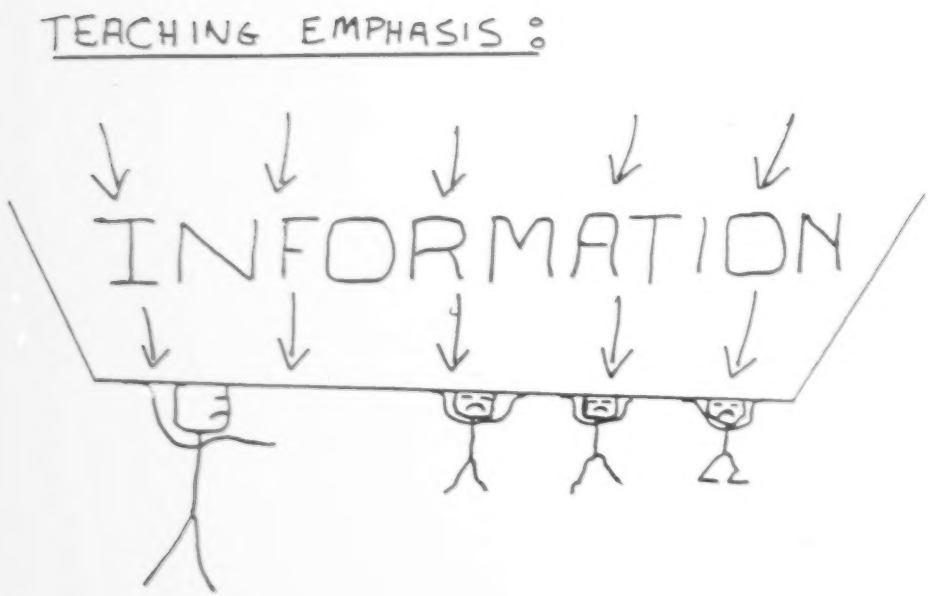

FIGURE 2 - A traditional emphasis on teaching information places an increasing burden on teachers and students.

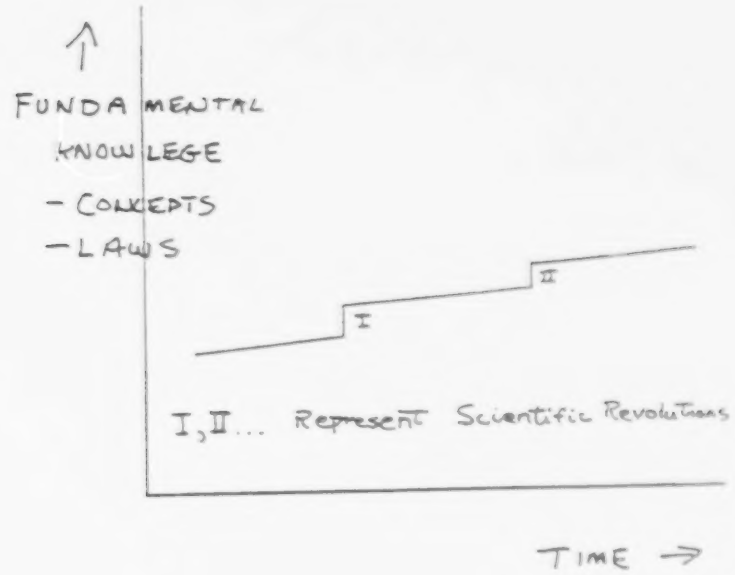

FIGURE 3 - Fundamental knowledge is relatively stable. During scientific revolutions there is a modification, but not necessarily a displacement of previous knowledge.

FIGURE 4 - Teaching which emphasizes understanding of relationships and the development of the interest and ability to acquire information independently is a necessary adjustment to the growth of science and its importance in our lives.

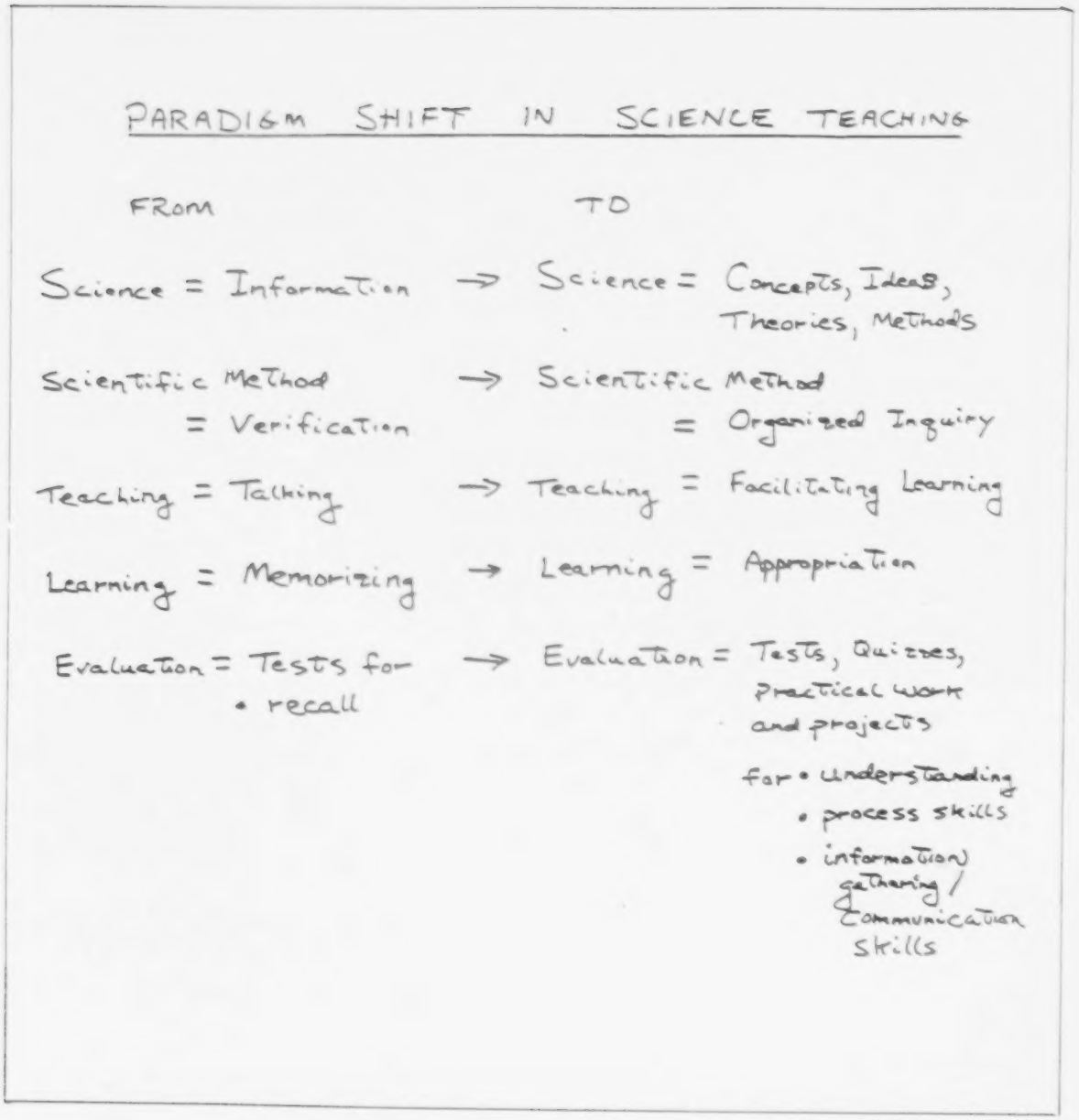
PARADIGM SHIFT IN SCIENCE TEACHING
FROM
TO
Science = Information → Science = Concepts, Ideas, Theories, Methods
Scientific Method = Verification → Scientific Method = Organized Inquiry
Teaching = Talking → Teaching = Facilitating Learning
Learning = Memorizing → Learning = Appropriation
Evaluation = Tests for • recall → Evaluation = Tests, Quizzes, Practical work and projects for • understanding • process skills • information gathering / communication skills

FIGURE 5 - Nothing less than a paradigm shift in science teaching is at issue in the current discussions of science education world-wide.

same vein, Baez (1976, p.93) pleaded "for a more direct involvement by at least some of the teachers in the creative process that takes place when the new materials are first being dreamed up." Havelock (1975, p.326) has argued for "people who can work in the middle between research and practice" and proposed "national systems for coordinated research, development, dissemination and utilization, systems which are simultaneously national, regional and local and in which there is a continuous chain of interdependence and two-way linkage from researcher to practioner to consumer."

The Atlantic Science Curriculum Project has been fashioned in response to the critiques of the preceeding curriculum reform movement. It represents a new wave of curriculum reform. Sustenance and inspiration for the Project have been provided by recent Unesco meetings, the symposia organized by the International Organization for Science and Technology Education, with which ASCP is intimately connected, and the recently concluded study by the Science Council of Canada of science education in Canada. (See Unesco, Science and Technology Education and National Development, 1983; C.McFadden (ed), World Trends in Science Education, 1980; G.Harrison (ed), World Trends in Science and Technology Education, 1985; G.Orpwood and J.P.Souque, Science Education in Canadian Schools, 3 Volumes, 1984.)

Evidence that the Atlantic Science Curriculum Project is part of a significant reform movement, not an isolated attempt to solve curriculum and instruction problems at the junior secondary level in science, can be found in the recently adopted policy position of the U.S. National Science Teachers Association on junior high and middle school science. (See The Science Teacher, September, 1986, p.13-14). Without any prior contact with the members of the committee that drafted the NSTA policy statement, the Project had independently arrived at a virtually identical position, evidenced in the products of its work (published under the title, SciencePlus), in particular in the introductory statements to the student textbooks and teachers resource books.

The Atlantic Science Curriculum Project has aimed beyond the development of model curriculum units or an optional, experimental course. The Project represents an attempt to introduce the essence of the current reform movement into the mainstream of teaching. Its impact will be one measure of the potential for success of this movement. By institutionalizing the Project at the University of New Brunswick, the Atlantic Science Curriculum Project has held the door open for sharing its work through further national and international collaboration.

SciencePlus represents a response to the problem presented to teaching by the continuing growth of knowledge (Figures 1 and 2). It has adopted the focus given by the previous period of reform to fundamental knowledge, recognizing the relative stability of this knowledge. It has further enhanced attention to developing students' information processing skills (Figures 3 and 4). It is designed for learning through organized, guided inquiry. As such, it identifies science with inquiry, rather than dogma.

SciencePlus supports a paradigm shift in science teaching (Figure 5). In this respect, it is uncompromising. In particular, there are no word lists, definitions or summaries to substitute for thinking. (New words are introduced in context. Authors have used as a criterion for the introduction of a new word the requirement that the concepts the word represents are fully developed through the learning activities in the text.) The aim is "minds on".

The common practice of "hands on, minds off" is discouraged by learning activities consistently designed for "minds on". Approximately two-thirds of these activities use paper resources, principally those provided in the student textbook. One-third involve hands-on explorations, usually utilizing materials that are "user-friendly" and readily available. Science-related careers are represented through interviews and projects. Understanding of concepts and ideas is reinforced through application to related technology and social issues. The links between science, technology and society are further emphasized in the context of projects designed for the development of learner independence.

The developers have intended that one result of the Project be a resource book which shares among teachers the best of the teaching ideas they have developed and may develop in the future. The Teachers Resource Book which accompanies each volume of SciencePlus is contained in a three-ring binder. It can, therefore, continuously be improved through the sharing and adding of new ideas, ideas shared locally or through ASCP with all of the users.

Introductory material is provided in the Teachers Resource Book which can serve the individual teacher and as an inservice document for group discussion and work. It includes explanations of the major features of SciencePlus, advice on an appropriate assessment strategy and a model to aid in the development of test items. For each chapter of the student text, the Teachers Resource Book provides a unit summary and overview to help the teacher get oriented on the unit. Advice is given about any advance preparation that may be needed and lists of needed materials are included. Teaching advice is given in the form of suggestions and alternatives. Answers to questions posed in the student text and some scientific background information is provided. And sample test items for the major objectives of the unit are included.

The Atlantic Science Curriculum Project has never intended that materials it has developed stand alone. If anything has been learned from past experience in attempts to renovate curriculum and instruction, it is that change is a process, not a product. New curriculum materials can support the process; they cannot substitute for it. A big job remains, one that will take the concerted, collegial action of the teachers, supported by science consultants, supervisors and university science teaching specialists and by the scientific and educational community as a whole.

Effecting change in curriculum and instruction

The need for concurrent, mutually supportive change in all the essential elements of the educational system can be understood most clearly in relation to the magnitude of the present task. The basic challenge to the current reform movement is to effect a paradigm shift in the dominant method of teaching. This movement envisions teacher guided learning as a preparation for life-long learning. In other words, it is not only directed to change in curriculum emphases and instructional practices; it prepares for a change in the very concept, duration and role of education. Such a change, no matter how much it may be supported by the teachers, cannot occur without concurrent changes in educational policy, curriculum materials and teacher education, to name three of the elements.

In the context of a socio-historical analysis of the Nuffield projects in the U.K., Mary Waring (1979, p6) has suggested that "educational dysfunction may now have reached a stage at which, for the first time, really large-scale

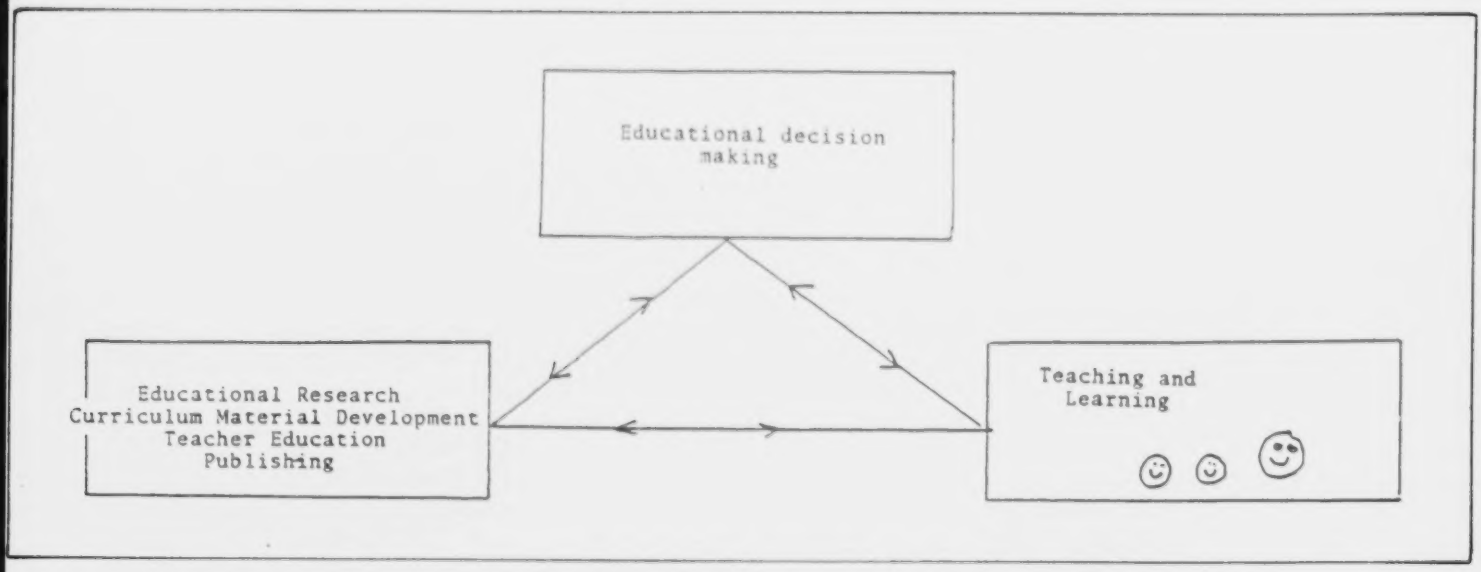

FIGURE 6 - Desirable relationships between some of the essential elements in the process of educational renovation.

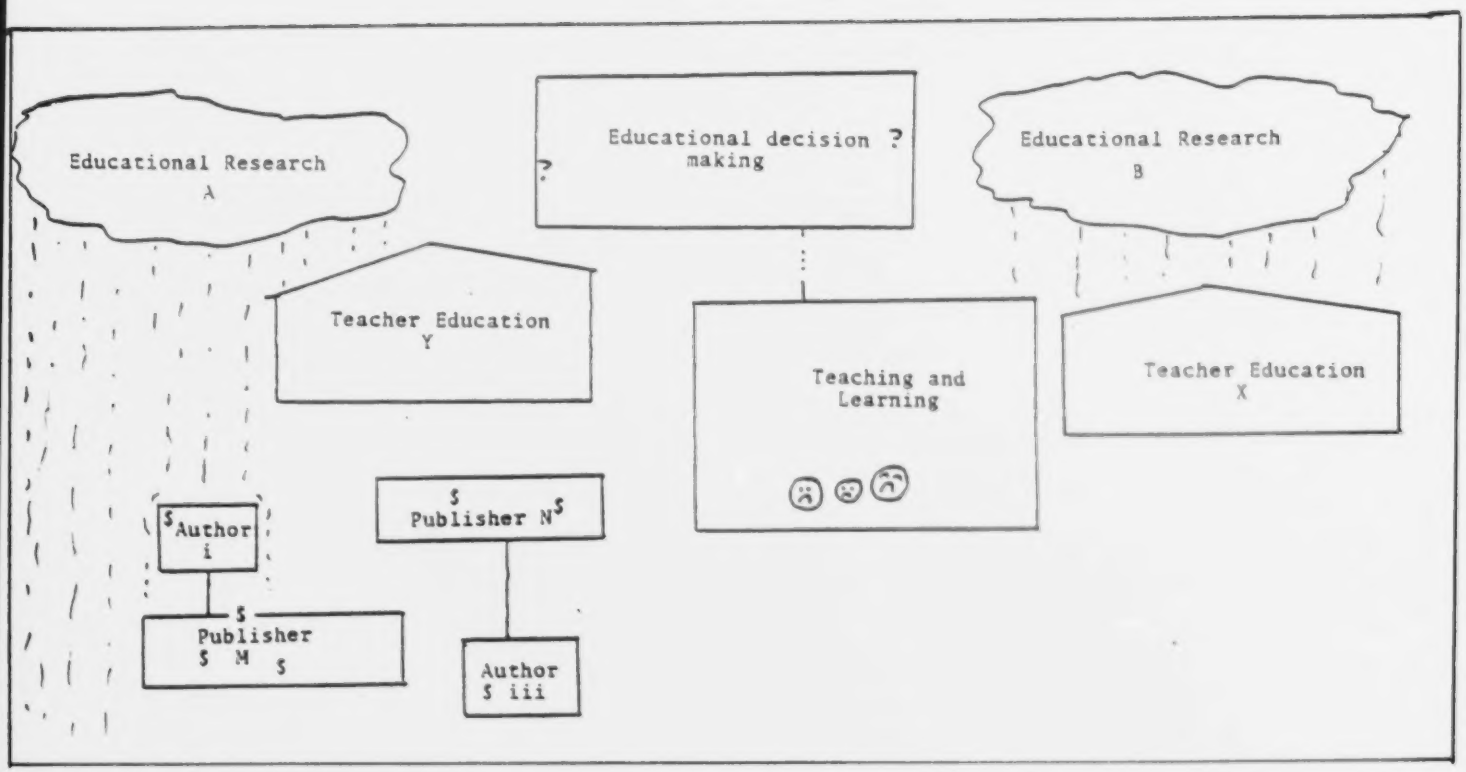

FIGURE 7 - Questionable relationships between some of the essential elements in the process of educational renovation.

change may be necessary, change confined not simply to institutional structure or curriculum content, but change involving the restructuring in time as well as content of the whole of education." All innovation, she points out, let alone a change of great magnitude, involves a shift of equilibrium. Since a state of equilibrium minimizes tensions, the status quo possesses enormous inertia, favoring the maintenance of traditional approaches that have shown themselves to be at least minimally satisfactory.

The question exists whether the goal of a paradigm shift in science teaching is achievable outside the context of a change in social system. However, since humankind may not long survive without a major adjustment in relations between countries with different social systems and without a change in humankind's relationship to nature, the time seems propitious for an educational change which facilitates these adjustments and changes. In other words, the present world-wide reform movement in education appears to coincide with necessary changes in the relations between nations and the relations between people and nature, that is, with the social reform movements for peaceful coexistence and the conservation of nature.

To assist those engaged in the educational reform movement, the remainder of this paper considers the necessary and actual relationships between curriculum materials development and the various other essential elements of the process of educational renovation. Figure 6 illustrates the desired relationships, which can be contrasted with Figure 7, which depicts the questionable relationships which sometimes appear to prevail.

Team development of curriculum materials.

The experience of the Atlantic Science Curriculum Project speaks unequivocally for curriculum development by teams of highly committed and knowledgeable people. To sustain a project of this type, there must be a high degree of commitment to improve education. To contribute something of lasting value, the team must possess advanced knowledge of both science and education. There can be many ways for a team to constitute itself and function successfully, but there is likely no substitute for extensive collaboration within the team and consultation without.

The team which has led the Atlantic Science Curriculum Project and done the principal share of writing includes educators with research experience in science and education, as well as teaching experience at all levels in the educational system. This team has shared the writing responsibility.

The Project Director has been responsible for developing preliminary outlines for all units to ensure appropriate content and sequence and to check-up, review, and correct the results in light of classroom experience with the units. This latter process has led to the rejection of many manuscripts and substantial changes in others. Each principal author has worked closely with at least one and often several other authors in planning, developing and revising units. Finally, the Author-In-Chief has been responsible for editing all units to ensure a uniformly high quality of pedagogy and science. Frequently, this has meant further rewriting or significantly amending units. As a result of these various forms of input, every unit which has reached publishable stage is the result of extensive collaboration.

In addition to teamwork within the Project, there has also, in effect, been teamwork between authors working for the Project and the copy editors, graphic

designers, artists, photo researchers and other creative personnel employed by the Publisher, in other words between all involved in the process of creation and invention. This has included three stages of copy editing, first locally by a copy editor working closely with the authors, second in connection with the preparation of the trial edition and finally in connection with the post-trial revision of the manuscript for publication. Without this kind of teamwork over the many stages included in the process of invention, creation, testing, revision and production, the result obtained would not have been achievable.

A strong educational motivation is likely the only one that will sustain a reform-minded Project through its formative years. There is likely no commercial reward commensurate to the work required. Certainly the royalty reward, if there is any, is not immediate. In the case of the Atlantic Science Curriculum Project, the authors had jobs in education, to which they could bring the benefits of their extramural labours. Most enjoyed the encouragement and support of their colleagues and employers, at least partially reducing the tension between the long-range commitment required by the Project and the more immediate teaching and research tasks that had to be fulfilled in connection with their jobs and which produced tangible results more quickly. On the whole, employers were reasonably generous in appraising the authors' curriculum development work when job promotions were being considered.

The experience of the Atlantic Science Curriculum Project does provide an answer to the question of the feasibility of the teacher as a curriculum developer. The average curriculum unit developed by the Project required the equivalent of nearly a full year of creative labour. The result was a unit worthy of inclusion in the first printing of a textbook. Given that the average teacher teaches at least eight different units in a year, and has been teaching those units for less than six years, it can be concluded that the average teacher should not expect or be expected to develop at a desirable level of quality all the materials students may require. Rather, the teacher's creativity is likely enhanced by the opportunity to add to existing materials, provided these have been written with account of what is known about science and learning.

On the other hand, a curriculum project cannot hope to renovate education without basing itself in the classroom. This means classroom testing of all materials and the active involvement of articulate, knowledgeable teachers at all stages of the developmental process. Formative evaluation preceding the writing of curriculum materials should in essence be an extensive consultation with the teachers. Teachers currently in the classroom should be included in the curriculum writing team and classroom testing of new materials should be used as a principal means of feedback and correction. Finally, pilot testing of new materials before school adoption provides a measure both of the materials and of the teachers' preparedness for change. Only by the determined, collective effort of the teachers, sharing ideas and supporting each other, can education be renovated. In this sense, the guiding partner in the team which develops new curriculum materials is the teacher, whose preparedness, desire and ability to make a change in teaching will determine the outcome.

Educational policy and curriculum materials development

To effect change in educational practice, curriculum materials and educational policy should support each other. The main provision for this across a broad

range of educational jurisdictions is a climate of opinion established in part through organizations, conferences and publications which link curriculum developers, teachers, consultants, supervisors and researchers. In addition, the Atlantic Science Curriculum Project has included in its leadership team provincial and school board science consultants and curriculum supervisors. Their inclusion has not only been important in obtaining cooperation from schools within the Atlantic region. Curriculum supervisors and consultants have brought to the Project a wide range of knowledge and experience of teaching practice and efforts to effect change. Two of them are among the principal Project authors.

In addition to its very positive experience, the Atlantic Science Curriculum Project has also encountered some problems of policy development and implementation that require attention and action. Operative policy in Canada takes the form of instuctional guidelines, the selection of textbooks, the setting of provincial, school board and school-wide tests and the supervision of schools and teachers. The amount of research and effort associated with the development and implementation of policy is necessarily limited by the size and resources of an educational jurisdiction and in some cases is extremely modest in relation to the tasks undertaken and the decisions being made.

Provinces and schoolboards attempt to go beyond the selection of textbooks by providing guidance to educational practice. This effort frequently includes the development of curriculum outlines and instructional guides. In the case of the larger provinces or boards, these documents are frequently made mandatory for practitioners, authors and publishers. Less frequently, an educational jurisdiction will extend its role to the development and testing of commissioned curriculum materials. This association of policy development with the writing and classroom testing of supporting materials enables an educational jurisdiction to adjust both policy and materials in the light of classroom experience to achieve the best possible results in a given situation. Such an association of curriculum materials development and policy formulation is unfortunately not the usual situation. Indeed, it can happen that a curriculum project which <u>has</u> translated curriculum plans into classroom practice and made the necessary adjustments in curriculum materials can be required to ignore its research in favour of conforming to mandated curriculum guidelines which have not been so tested.

There is clearly room for considerable improvement in bringing policy making and curriculum materials development together to achieve the best results possible. Some of the current problems in this respect may simply arise from a lack of recognition of the magnitude of the task of educational renovation and therefore the need to apply far greater resources to curriculum plannning, curriculum materials development and supporting research than is presently the case in even the largest Canadian educational jurisdictions. The existence of more projects like the Atlantic Science Curriculum Project, covering other subjects and levels and operating in every educational jurisdiction, would assist educators to overcome the existing problems in the way of a more fully professional effort to renovate curriculum and instruction.

<u>Curriculum materials development and publishing</u>

The relationship between curriculum materials development and publishing may be pivotal to the success of educational reform efforts. There are two fundamental models for the relationship between author and publisher, depending on who holds copyright. In the case of the major curriculum projects of the

latter 50s through the early 70s in the United States and the United Kingdom, copyright was held by institutions or organizations which represented the innovators. A survey of the science textbooks in the reference library at the University of New Brunswick reveals that outside the products of these curriculum projects most, if not all, science textbook copyrights are held by publishers. In effect, the writers of most science textbooks are commissioned employees. Subject to certain rights of the writers, the publisher is at liberty to make changes deemed necessary to render the manuscript fit for publication (see, for example, Sarna, 1980). In effect, the publisher is the developer, a role publishers at least occasionally publicly claim for themselves.

A report prepared for the Secretary of State (1978) on English Language Publishing in Canada observed (p.58) that "...Canadian Elhi editors, in some firms, have assumed greater responsibilities in the production of textbooks in conjunction with authors." In a position paper on the marketting of educational books in Canada, prepared for the Ontario Royal Commission on Book Publishing, Totton (1972, p.298) noted that "because the goal of marketting is to generate the maximum actual profit, editorial and marketting policies are inextricably linked in educational publishing. Basically a publisher can increase his profit by reducing costs and/or increasing revenue." For speed and efficiency, publishers have reason to prefer control.

The primary motive of publishers is not curriculum reform, even though individual publishers may take satisfaction in contributing to educational advance. Publishing is conservative. A perusal of the junior high science textbooks displayed by the major publishing houses at the recent annual conference of the U.S. National Science Teachers Association revealed an amazing uniformity of approach. Except for the addition of special features which addressed the names but not the content and spirit of recent curriculum innovations, the books seemed identical to those used in schools over 30 years ago. The discrepancy between the pedagogy represented in those textbooks and that being presented to the conference by teachers was remarkable.

Initiative to develop curriculum materials which match the content and spirit of the current reform movement should come from educators, who will have to take the responsibility that holding copyright to a textbook entails. Textbook writing does not (or at least should not) end with the publication of a first edition. Textbooks require modification for context in relation to the different educational jurisdictions which may use them and regular correction and updating in the light of experience and further advances in science and education. A responsible and responsive curriculum development project entails a long term commitment on the part of the individuals and organizations involved.

If educators are able to obtain significant funding for curriculum development (and that is not easy to do in Canada), the remaining cost of production and marketting of the curriculum products will not likely be included. A publisher with the capital to undertake this investment will aim to minimize its risks. Curriculum developers are well advised to procede at least through preliminary field testing of materials before contracting for publication. In that case, the developers can reasonably insist on retaining copyright and can negotiate for further field testing under their direction, employment by the publisher of professional copyeditors, textbook illustrators, graphic designers and photo researchers and generous use of colour. Curriculum developers may also wish to restrict the publisher's right to publish and market the work in

question to a specified market, retaining the right to contract separately (possibly with another publisher) for other markets. The marketting capacity of the publisher may be a major consideration in this respect. In any case, a publisher is unlikely to accept this restriction unless it can be reasonably confident of recovering its investment and making a profit in the restricted market.

The University of New Brunswick holds the copyright for the materials authored by the Atlantic Science Curriculum Project. All the commitments outlined above have been made by its publisher, Harcourt Brace Jovanovich, Canada except for a restriction on the right to publish. Given the international marketting capability of Harcourt Brace Jovanovich and a high level of cooperation between the Publisher and the Project, such a restriction does not appear at present to limit the Project's capacity to influence and assist curriculum reform efforts nationally and internationally.

If the Atlantic Science Curriculum Project provides a model for curriculum development which proves useful to educators working in other subject areas or at other levels in science education, then the Project will thereby have made its greatest contribution to education. If at the same time, Harcourt Brace Jovanovich, Canada achieves a financial success in the sale of SciencePlus, the working relationship between the Atlantic Science Curriculum Project and Harcourt Brace Jovanovich, Canada may provide a model for other author - publisher relationships in education. That too would be a measure of success.

Implementation by the teaching profession

Since the curriculum reforms initiated in the latter 50s, there has been a change in the teaching body that favors the success of the current educational reform movement, namely, the higher level of education and professional involvement of the teachers. Within the teaching profession there are many who possess the highest levels of knowledge and understanding of science and education. Therefore, leadership for change from within the profession, essential to any real progress in teaching, can join leadership from without. Leadership of the Atlantic Science Curriculum Project, for example, has emerged entirely from within the teaching profession. Regionally, at least, the Project enjoys the confidence of both the teachers and the scientists.

Having studied and learned from the experience of the prior reform effort in science teaching and from research on curriculum implementation, including the recognition of factors affecting implementation (e.g. Leithwood, 1982), the use of appropriate forms and methods of inservice work with teachers (e.g. Fullan, 1979) and the ability to recognize the level of use of an innovation (Hall et al, 1978), the Atlantic Science Curriculum Project has been able to provide leadership to educational change in Nova Scotia, where SciencePlus1 was introduced into most grade 7 classrooms in the 1986-87 school year. Beyond Nova Scotia, the implementation of the SciencePlus program will require knowledgeable and committed leadership from educators who in most cases played no part in the development of the materials, but share the same goals and have a similar acquaintance with previous reform efforts and the results of relevant curriculum research.

Wherever leadership for reform exists from within the science teaching profession, the battle for change can be won. But the need for concerted action should not be minimized. SciencePlus is a resource which supports a paradigm shift in teaching. Without a conscious intent by the teachers to make

such a shift, no progress can be expected, with or without SciencePlus. Local leadership for change is indispensable.

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